Zinc Orthophosphate - $Zn_3(PO_4)_2$

Background

Zinc Orthophosphate (ZOP) was recognized by the EPA as the Best Available Technology (BAT) for the reduction of lead and copper in water supplies when the EPA first published the Lead & Copper Rule, which addresses control of these hazardous metals in drinking water, in 1991. ZOP had been in use since the late 1960's.

The proposed addition of the ZOP to the water supply in Croton would aid in reduction of brown water events, help extend the life of older pipes, and aid in reducing lead concentrations (which come from building water systems, not from the public distribution system) in the water by controlling the corrosiveness of the water and forming a barrier between the pipe wall and the water in the pipe.

Additive Details

The actual make-up of the additive proposed to be used is:

38% Phosphoric Acid H_3PO_4

16% Zinc Chloride $ZnCl_2$

The remainder of the additive (48%) is inert.

As a side note, phosphoric acid is present in high concentrations in Coca Cola, Pepsi, and other cola products. It is listed in the ingredients of the cola drinks.

Of the chemicals in the additive, the actual percentages of specific compounds are:

37.5% PO_4 (phosphate)

7.5% Zn (zinc)

Dosage

The amount of the ZOP additive to be injected into the water will be regulated based on the resulting zinc concentration in samples of the water. Initially, a zinc concentration of 1 mg/L in samples will be the target dose. Once the initial passivation (initial formation of the hard, stable surface on the interior of pipes) of the distribution system is completed, the additive dosage will be adjusted downward until a zinc concentration of about 0.3 mg/L is maintained.

Using round numbers, assume that a concentration of 10 mg/L of ZOP is added to the water supply. At 10 mg/L addition of ZOP, 3.75 mg/L of phosphate will be added to the water system, equating to 3.75 gallons per million gallons of water used.

Phosphoric acid disassociates in water, as do all acids, into hydrogen and phosphate. The zinc chloride also breaks up into free Zn and Cl_2. The breakup of the individual chemicals in the additive allows for the formation of the ZOP.

Activity in the water supply

As there are more phosphate ions in the ZOP solution than zinc, there is the potential for the formation of calcium phosphates, among many other salts, when the additive is injected into the distribution system. A salt, in chemical terms, is an ionic compound that can be formed by replacing one or more of the hydrogen ions of an acid with another positive ion. However, within the distribution system there is much iron (Fe^{3+}) present, as evidenced by the brown water events. It is most likely that free phosphate ions (PO_4^{3-}) in the ZOP will bond with iron in the distribution system.

There are many forms of calcium phosphate. One form is known as:

hydroxylapatite $Ca_{10}(PO_4)_6(OH)_2$

Approximately 70% of bone is hydroxylapatite.

Calcium is usually present in water supplies. Recent sampling of the Croton water supply showed average calcium concentrations of about 35 mg/L.

The ±35 mg/L of calcium present in the water supply represents approximately 3% of the recommended daily intake of calcium. Clearly, drinking water should not be considered as a significant source of calcium.

From the National Institute of Health (NIH)

Table 1: Recommended Adequate Intake by the IOM for Calcium

Male and Female Age	Calcium (mg/day)	Pregnancy & Lactation
0 to 6 months	210	N/A
7 to 12 months	270	N/A
1 to 3 years	500	N/A
4 to 8 years	800	N/A
9 to 13 years	1300	N/A
14 to 18 years	1300	1300
19 to 50 years	1000	1000
51+ years	1200	N/A

*mg=milligrams

IOM=Institute of Medicine, a branch of the Nat'l. Academy of Sciences

While there is the potential of the formation of calcium phosphates in the water supply, due to the addition of the ZOP, the concentration of the ZOP proposed to be added to the water supply is so low that no detectable change in the water chemistry is anticipated, except for the detection of the zinc.

While it is possible that insoluable forms of calcium phosphate may form due to the presence of additional phosphate in the water supply, it should be considered that phosphate is normally present in water. In addition, if the 1-2 mg/L of added phosphate available to bond with the calcium in the water supply due to the addition of ZOP was not present, it is very likely that available calcium in the water supply would form other, also insoluable, compounds with other chemicals present in the water supply.

Clearly, inadequate consumption of calcium leads to poor bone density. However, calcium is not present in drinking water in a concentration high enough to significantly alter the health, for

better or worse, of those consuming the water. One would have to drink 9 gallons of water per day to get the recommended calcium dosage.

Impacts of drinking the water

While there is a large amount of information regarding the impact to calcium concentrations in the body due to excessive consumption of cola products containing phosphoric acid, consuming water having very low concentrations of phosphate will not alter the bone density of the individual drinking the water. The effect of consuming *phosphate*, which is a normal part of a diet, should not be confused with the effect of consuming *phosphoric acid*. As the phosphate has likely bonded with the zinc, iron, or possibly calcium, or other chemicals present in the water, before it is ingested, it then would not significantly influence the calcium level of the person consuming the water.

Conclusions

The implication of the statement by Mr. Ferguson is that the addition of ZOP will alter the water supply in a way that causes it to no longer be a source of calcium. In actuality, the water is not a significant source of calcium, and the addition of ZOP will have minimal impact on the available calcium in the water. Or, more likely, Mr. Ferguson infers that consumption of free phosphates in the water will reduce the calcium in the body, leading to osteoporosis. Available reporting on the subject does not indicate such an impact from consuming phosphate, and the available amount of phosphate in the ZOP treated water would be minute.

The statement by Mr. Ferguson that addition of ZOP to the water supply is harmful to the health of those consuming the water is not supported by available reporting on the topic. There are no known adverse health impacts due to addition of a corrosion control inhibitor to a water supply.

The central point is that addition of a chemical (ZOP) that is recommended by the EPA, approved by the American Water Works Association (AWWA) and NSF International (formerly the National Sanitation Foundation,) and which is added in the same or a similar form in virtually all the public water supplies in Westchester County, results in a barely detectable change in the calcium concentration in the water supply, while preventing an increase in the lead concentration at taps. While there is no known concern regarding the addition of ZOP to the water supply, the presence of lead in drinking water is universally recognized to be a hazard to all water consumers, especially children, at any detectable level.

Therefore, any public concern regarding the small amount of ZOP additive should be greatly outweighed by the benefit of the control of lead in the water supply.